



DISCIPLINE-BASED INITIATIVES

EXPRESSION OF INTEREST

APPLICATION PROFORMA

<i>Discipline</i>	Biotechnology	
<i>Applicants (List) + Details, Role in Initiative</i>	<p>University of Queensland – Dr. Damian Hine UQ Business School; Assoc. Professor Ross Barnard Biotechnology Programme Co-ordinator, BACS Faculty.</p> <p>University of New South Wales – Dr. Will Rifkin, Science Communication; Dr. Wallace Bridge, Entrepreneurs in Science.</p> <p>Flinders University – Professor Chris Franco, Biotechnology Programme Co-ordinator, Dr. Fiona Young, Faculty of Health Sciences.</p> <p>Monash University – Dr. Phillip MacKinnon, Biotechnology Co-ordinator, School of Medicine.</p> <p><i>Task Allocation – Exploring initiatives in:</i></p> <ol style="list-style-type: none"> 1. Cross-disciplinarity best practice identification, as well as identifying diversity in programs and practices – Flinders and Monash 2. Uni-BEN and ABEN liaison - UNSW 3. National Industry placement scheme - Monash 4. Web site development - Flinders 5. Integrating problem-based learning into existing Biotechnology programs at the member universities – UNSW 6. Comparing beyond Biotechnology Programs – All members 7. Integrating industry input into skills requirements and expectations – UQ 8. Graduate Attribute Identification & Curriculum Mapping for Biotechnology Degree Programs – Flinders & UNSW 9. A 'how to' booklet on establishing a successful biotechnology program – Monash/UQ 10. Collaborating and comparing with programs internationally – UQ and UNSW 11. A graduate engagement strategy through alumni – All members 12. Association with ABEN - Flinders 13. School visits program and resource materials – Flinders and UNSW 14. Shadow an industry person for a day – Flinders and Monash 	
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<i>Interim Report</i>	<i>1st March, 2007</i>
<i>Final Report</i>	<i>31st July, 2007</i>

PROPOSAL BRIEF

<i>Title</i>	Extending teaching and learning initiatives in the cross-disciplinary field of biotechnology.
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Tick the relevant category

- ☒ Review of Prior Investigation and Scoping for the Future (Category A-2)
- ☐ Initial Scoping Investigation (Category B)
- ☐ Service Teaching Discipline (Category C)
- ☐ Professional Degree Programme (Category C)

1 *Aims (Vision)*

Our AUTC Biotechnology study (Phases 1 and 2) identified a range of areas that could benefit from a common approach by universities nationally. A national network of biotechnology educators needs to be solidified through more regular communication, biennial meetings, and development of methods for sharing effective teaching practices and industry placement strategies, for example.

Our aims in this proposed study are to:

- a. Revisit the state of undergraduate biotechnology degree programs nationally to determine their rate of change in content, growth or shrinkage in student numbers (as the biotech industry has had its ups and downs in recent years), and sustainability within their institutions in light of career movements of key personnel, tightening budgets, and governmental funding priorities.
- b. Explore the feasibility of a range of initiatives to benefit university biotechnology education to determine factors such as how practical each one is, how much buy-in could be gained from potentially participating universities and industry counterparts, and how sustainable such efforts are. One of many such initiatives arising in our AUTC Biotech study was a national register of industry placements for final-year students.
- c. During scoping and feasibility study, to involve our colleagues who are teaching in biotechnology – and contributing disciplines. Their involvement is meant to yield not only meaningful insight into how to strengthen biotechnology teaching and learning but also to generate ‘buy-in’ on any initiatives that result from this effort.

2 *Investigation Strategy*

In this section you should ensure that you address the selection criteria, particularly those not covered by the following sections

Task allocation to member universities

On the receipt of the Carrick call for proposals, the team identified a list of items that our previous study revealed would be worth pursuing. Within this list, we have now distinguished those elements that Carrick have identified as core tasks for this follow up study, separating them from the initiatives that we would like to pursue in the long term. For this study, we are proposing to assess the feasibility of these "new" initiatives, as well as to elicit additional possibilities, during our survey of our academic colleagues in biotechnology and our industry counterparts.

Two types of tasks are necessary in this study. First, we need to revisit the programs and industry employers surveyed in our initial, AUTC-funded study and update that report's findings. These tasks, begun or completed in our previous study, are underlined below.

Second, we need to assess opportunities for developing and sharing effective practices in teaching, updating the curriculum, and management of biotechnology programs. These tasks include new initiatives listed below, extension and pursuing sustainability for the underlined initiatives, and eliciting additional ideas from those who offer biotechnology degree programs, their students, and the employers of those students.

1. Identification of best practices in managing a program that requires teaching from across a range of disciplines – from basic science to applied science to business skills and insights. ,
– **Flinders and Monash**
2. Uni-BEN (University Biotechnology Educators Network) for sharing best practices in teaching, curriculum development, and industry links; updating our members' list and exploring possible ways of sharing best practices effectively – Flinders
3. National Industry placement scheme – **Monash and UQ**
4. Web site development to support national initiatives, such as Uni-BEN and placement scheme - Flinders
5. Integrating problem-based learning into existing Biotechnology programs at the member universities – **UNSW**
6. Comparing beyond Biotechnology Programs – **All members**
7. Integrating industry input into skills requirements and expectations – UQ
8. Graduate Attribute Identification & Curriculum Mapping for Biotechnology Degree Programs – **Flinders and UNSW**
9. A 'how to' booklet on establishing a successful biotechnology program – **Monash/UQ**
10. Collaborating and comparing with programs internationally – UQ and UNSW
11. A graduate engagement strategy through alumni – **All members**
12. Association with ABEN – Flinders and UNSW
13. School visits program and resource materials – **All members**
14. Shadow an industry person for a day – **Flinders and Monash**

Follow up initiatives for the scoping exercises:

Each of the following headings corresponds with the task allocations identified above.

1. Identification of best practices in managing a program that requires teaching from across a range of disciplines – from basic science to applied science to business skills and insights.

Cross disciplinary programs keep getting touted as the wave of the future. Yet, as some of us have found, there are tremendous institutional hurdles that need to be cleared. How does one keep integrity in the educational process and a sense of professional identification in the students when they are studying under a range of different discipline headings?

Other examples of cross disciplinary programs involving science disciplines would include some that are on the rise, such as nanotechnology and forensic studies, and some that have been around for a while, such as safety science (OH&S) and environmental studies.

When a program is taught by people from a range of disciplines, it might be more difficult to disseminate good teaching practices within the program. That is, those who teach into the program will not run into one another very often. Challenges include not only making sure that content links up well between courses but also that methods of instruction continue to improve across the board over time.

More student-centred methods of teaching would be worth particular attention, as science tends to be dominated by the lecture mode of instruction accompanied by pracs/labs. Interestingly, medicine -- which can be viewed as applied science or even engineering -- has been shifting to problem-based and scenario-based learning. One wonders what future shifts in methods of instruction might occur in biotech, and how such methods may then creep into other areas of science teaching.

Through this exercise, we are seeking to observe and document best practice models of managing cross-disciplinarity in biotech programs. In this way, we can look at the programs more holistically than we were able to in the AUTC project. This then also links better with the need for programs to respond more readily to quickly evolving industry needs, and industry-based projects could also be accommodated more readily. In other words, lessons need to be shared on how to manage a biotech program to make it a successful and sustainable cross-disciplinary undertaking.

We would revisit the diverse range of programs and practices across the country to assess which management strategies are proving successful and in what particular challenges need addressing.

2. Uni-BEN

Revisiting everyone in the Uni-BEN network to ask how things have changed since the AUTC project. Good reasons for this effort are the rapid pace of change in the biotechnology arena and the need for revisiting our contacts to help strengthen Uni-BEN.

We will also scope out a mechanism for sustaining national synergy in this network. That could be as simple as creating a network node or knowledge broker role, someone(s) to work among universities and liaise with industry, recent graduates, etc. The study will aim to define a job description agreed on by all key stakeholders.

One concept under consideration is for twenty universities to support this initiative with \$5000 each (much less than our in-kind time in doing the study) to pay for such a role to be created at a national level.

3. National Industry Placement Scheme for Students --

This scheme was discussed at the Uni-BEN meeting in November 2004. A clear direction for development was not arrived at. There was, however, deliberation about the potential usefulness of explaining common characteristics of industry placements (meaning placements during the fourth year of study) as a way to reduce anxiety in industry about taking on supervision of these advanced undergraduates.

4. Website Development -- for Educators but also for Industry Placements --

Limited progress was made due to insufficient funds during the AUTC project. This initiative was also beyond the initial brief of the project. It would be valuable to achieve progress on developing web pages on the Uni-BEN site to facilitate industry placements. Progress here depends on building the links between industry and Uni-BEN.

Ongoing coordination of Uni-BEN is desired to build inter-university and university-industry relationships; the coordinator would also oversee maintaining and developing the website and listerv.

The extensive work undertaken by Will Rifkin in creating the World-Wide Day of Science, and prior to that the development of SkillCity, will be used to inform development of the website around which the networks will pivot. The World-Wide Day of Science (www.science.unsw.edu.au/worldwide) involves students and academics on every continent. SkillCity (<http://skillcity.iaaf.uwa.edu.au>), now in its eighth year, was developed by a team stretching across ten universities with funding from CUTSD.

5. Integrating problem-based learning into the Biotechnology curriculum

Looking across disciplines, science faces the key challenge of updating its university instruction in the absence of strong professional societies. Engineering seems much better in this respect, as one can see in significant moves toward strategies like problem-based learning. Biotech, as falling in some sense between engineering and science, might provide a good place to push for student-centred learning in science. Biotech lacks a professional society, but it seems to have industry interest.

Problem based teaching and learning methods fit well with the impetus to integrate industry representatives into the design and development of curricula. A greater collaboration and association with industry will also provide access for biotechnology programs to industry cases, which can create the foundation for problem-based applied and analytical approaches. We will investigate examples of best practices in integrating industry cases into the curriculum for the science, applied science, and business portions of biotech programs.

6. Comparing beyond Biotechnology Programs

In this next stage of development of the project, we intend to look beyond the biotechnology discipline in exploring best practice examples of both cross-disciplinarity and problem-based learning. That is, we will look into areas such as engineering and medical education for models that might be used in biotechnology teaching.

7. Integrating industry input into skills requirements and expectations.

This scoping exercise is an outgrowth of the AUTC-funded study of all undergraduate biotechnology degree programs in Australia. The AUTC study detailed what subjects are taught in first, second, third, and fourth year of all programs, and it relayed results of a survey of 60+ biotechnology employers on what knowledge, skills, and abilities they seek in new employees and which abilities they foresee developing on employment.

One main aim is to develop a set of metrics of skills needed by employers as industries and professions change over time. The result will foster a continual flow of quality information on industry needs for specific skills, abilities, and knowledge to the university networks in Biotechnology established under the AUTC grants.

The methodology would involve applying a form of the survey developed for the original Biotechnology industry study. The new survey approach would be used to generate updated data from employers. The method would be employed to gather data, at six-month intervals for two years, from a representative sample of companies, institutions, and industry players. This set of data will provide sufficient observations over time for trend analyses and measures of changing industry skill needs. These trends can then be gauged and compared with the changes occurring in the university programs being provided to see the extent to which graduate attributes keep up with the changing nature of employers, clients, and society.

This pilot study will involve: updating the Biotechnology survey content and undertaking further focus group data gathering exercises; conducting the surveys for the three disciplines simultaneously; the trial establishment of a university-industry forum to more formally create a two-way dialogue on an annual basis, thereby maintaining the dynamic feedback mechanism needed to achieve currency of curriculum required in these rapidly developing disciplines. The forum will be conducted as a further confirmatory technique to verify the results of the previous phases of the pilot study. It will coincide with an already planned 2007 meeting of the University Biotechnology Educators Network (Uni-BEN).

From the data gathered, two usable data sets will emerge: Distinct data sets for each discipline area with valuable information to dovetail in with the graduate attributes initiative proposed. Also

an aggregated data set will be established to provide indications of general changes in skills needs, which will inform universities and program co-ordinators. That is, to assure that the graduate attributes being developed are tomorrow's attributes and not yesterday's.

This element of the overall project will closely involve members of the Uni-BEN network in the compilation and analysis of data gathered, who will feed through results to their universities; industry representatives in the conduct of the field studies, and team members in cooperatively developing the comparative studies and analysis of these studies. The results will impact both the university sector, in the development of their programs in the three disciplines identified, and the industry sector, which will gain a more detailed appreciation of the programmes being run within the universities (one fruitful outcome of our Biotech focus groups) and will gain the opportunity to collaborate more closely in planning curricula to meet the skills needs of the future in their respective sectors.

Effectiveness of the industry survey methodology and resulting data will be gauged in terms of –

- the number of employers responding in each discipline area to the survey and participating in the focus groups;
- the number of university programs providing input in development and analysis of data from the industry survey and participating in the focus groups;
- correspondence between new survey and focus group results and prior data covering similar variables and issues; and
- qualitative assessment of validity of the data via industry, university, and combined university-industry focus groups.

8. Graduate Attribute Identification & Curriculum Mapping for Biotechnology Degree Programs.

The feasibility of identifying graduate attributes and curriculum mapping systematically in undergraduate biotechnology programs across Australia will be explored.

The effort is meant to explore the viability of building in three steps toward a national impact in the field. We will investigate the practicality of, first, a pilot project identifying graduate attributes in the Flinders University biotech degree program and then mapping them throughout the current curriculum (expertise developed in curriculum mapping in science at UNSW will be employed in this effort). The second step might be addressing an additional university program, employing the Flinders experience and outcomes to fashion their own list of graduate attributes (or just adopt the Flinders list) and map them throughout their curriculum.

The ultimate aim would be the third step. These experiences in identifying and mapping graduate attributes would be shared nationally via case studies published on a planned biotech listserv and website, as well as through the clearinghouse officer for this overall project. The culmination could be a national workshop on graduate attributes in biotechnology degree programs.

The point here is that we have conceived a plan for a national review of graduate attributes in biotechnology degree programs. In this initial scoping study, we can assess the viability and buy-in for this approach, refine our strategies, and potentially begin the curriculum mapping effort at Flinders University. More details of the strategy, as currently envisioned, are spelled out below.

Experience and the literature seem to agree that identifying graduate attributes and translating them into a form of relevance to a discipline is best done mainly by lecturers in that discipline rather than by outside educational experts. So, under our current vision for this effort, the exemplar University team will assemble lecturers who contribute to their program, as well as

local employers and representatives of current students and recent graduates, to identify a set of graduate attributes that they would like to imbue into biotechnology students.

The team will consult with contributing lecturers, and employ contributions from selected students, to map how these graduate attributes are addressed in their courses, both stated intentions and actual results. Again, having the lecturers involved has proven to be more meaningful – creating more understanding of graduate attributes and more reflection on teaching strategies -- than just having a research assistant scrutinise the subject outlines from a program of study. The students provide a 'reality check', identifying how what the lecturer senses they are delivering is perceived by students.

Then the team will share their results with the stakeholders – lecturers, students, and employers and discuss how suitable their current teaching is to achieving the graduate attribute goals that they are aiming for. Finally, the process and outcomes will be compiled into a case study for use by those who coordinate other biotech degree programs. A second university in the Uni-BEN network will be identified to undertake a similar identification, mapping, and documentation process.

The two cycles of identifying, mapping, and documenting will be completed in time to form the focus for a succeeding Uni-BEN workshop. Lecturers in the biotechnology degree programs at the exemplar University and one other university would be the immediate stakeholders involved. Local biotechnology employers in each city will be consulted as well to help to identify useful graduate attributes to aim for as well as to reflect on what graduate attributes have been achieved, a process extending the university-industry dialogue that has proven necessary in this rapidly developing, applied science area. These questions were initially explored in industry focus groups in 2004 as part of the second phase of the AUTC Biotech project.

The models created in these efforts will then provide a scaffold for similar efforts at other universities involved in the Uni-BEN network, which encompasses all twenty-seven undergraduate biotechnology degree programs in Australia. During this process, students and recent graduates will be consulted as key stakeholders in the education and employment process. The hope is that they will benefit, or create benefits for students who follow, from improvements in curricula and teaching methods resulting from reflection on coursework and teaching by the biotechnology lecturers.

The effectiveness of the graduate attribute identification and mapping processes conducted initially at the exemplar University will be gauged by several factors, including: (a) extent of participation in the process by lecturers; and (b) comparison of these participation levels and the lists of graduate attribute identified and mapped with results of similar efforts in other universities and other disciplines (such as comparison of the result for the exemplar university to the graduate attributes identified within the faculties of science at other universities).

Samples of assessment tasks (instructions and submissions) will be collected before the mapping begins and two semesters after it ends to determine the extent to which teaching and learning may have shifted as a result of attention to graduate attributes. Students will also be surveyed before and after to determine the extent to which they sense that graduate attributes in key areas are being addressed and addressed effectively.

A continuing dialogue with biotech employers will be supported to determine the extent to which graduates are satisfying industry needs in the graduate attribute areas. It was noted in the AUTC Biotech study that employers are particularly sensitive to certain employee attributes, like communication skills and levels of confidence in problem solving and laboratory work.

The aim of the project would be to have lecturers discussing and addressing graduate attributes more openly and in a more informed and articulate way, and to have graduate attributes addressed more systematically. This shift should be noticeable in the types of assignments

given and in the quality of those submitted. Ultimately, students will note how their abilities are increasing, and employers will recognise the changes, as well. Measurable outcomes should be evident initially in the two programs initially mapped, though national impact is ultimately intended.

9. A 'how to' booklet on establishing a successful biotechnology program.

The insights on managing cross-disciplinarity, on establishing a program from scratch, and on integrating new approaches into existing programs can be brought together in a hard copy publication (which can also be available on the web site) as a best practices tool for universities to follow and further contribute to. Making the guide a "living document" might be particularly appropriate given the rapidly evolving nature of the biotechnology industry and shifts in university enrolments and funding schemes. Such a guide could readily be useful for other seeking to create or manage other types of interdisciplinary degree programs.

10. Collaborating and comparing with programs internationally

Collaborative and comparative efforts internationally have already commenced with Cambridge University, through the Institute for Biotechnology, which runs biotechnology programs in the university. We also completed an all to brief international study as part of our Phase 1 AUTC biotech study, which we judged to be insufficient to include in our final report.

Sharing resources, student exchange, staff exchange, and comparing programmes has commenced. We will examine possibilities for creation of a co-ordinated resource sharing program.

The University of Queensland has MOUs and exchange agreements with biotechnology programs in Indian Universities for undergraduate and masters level biotechnology student exchanges and articulation of programs. UQ has also had exchanges on biotechnology with NUS and the University of California. UNSW has links to the UK Higher Education Network Centre in the biosciences, through these ties -- and the World-Wide Day in Science project -- connections to UK-based, biotech-related programs can be built.

11. A graduate engagement strategy through alumni – All members

There is a need for strategies to improve contacts with graduates from our biotechnology programs. This effort would help with developing industry links with employers (for placement and teaching purposes) and also support undergraduates in planning career paths. There are several international models of excellent practice in this area. As with other initiatives listed here, we will explore the feasibility of – and strategies for – alumni programs.

12. Association with ABEN – Flinders

Extend the association with K-12 biotechnology educators through cross-attendance at conferences, sharing resources, establishing events. This liaison effort would be a relatively minor element in the proposed scoping study. Its aims would relate to teaching public communication and education skills to biotechnology students as well as addressing issues of recruitment of new university students, which has proven to be a challenge – in Australia and around the developed world -- in a number of areas in the sciences and engineering.

13. School visits program and resource materials – Flinders and UNSW

As with task 12 above, this effort focuses on developing links between universities and schools. Team members in Adelaide already have a good connection with the Australian Maths and Science School (conveniently located on Flinders Uni campus). The Brisbane Uni-BEN meeting revealed that lecturers would like more info about teaching. School teachers would like to know more about Biotech research. It would benefit both lecturers and teachers to have more

interaction. We would assess the viability and challenges of having such outreach efforts based in biotechnology degree programs through our national survey to update our previous AUTC biotech study.

14. Shadow an industry person for a day

This initiative – if proven feasible -- would involve setting up and running a 'Shadow an Industry Person for a Day' pilot scheme. This strategy was suggested at the Adelaide industry focus group meeting. It would be a good way to build links between universities and industry as well as develop a local Uni-BEN network. It would involve making up a list of biotech companies and personnel willing to have a shadow – a biotechnology academic or perhaps a school teacher -- for a day / morning / afternoon.

An initial list would be established and then initial contacts made, before handing it over to a coordinator, who would then send the list to all biotech lecturers in the cities. They would follow up by speaking with them to obtain their availability and interests and preferred industry personnel, as chosen from the list. Then, the coordinator would match the interested lecturers with the industry personnel.

This strategy – if judged feasible -- could be trialled as a pilot scheme and then considered for transfer elsewhere. The initiative would then invite the lecturers to present their experiences locally (at a meeting of biotech lecturers, and perhaps invite local science teachers as well) and at the following Uni-BEN meeting.

Addressing the selection criteria through the scoping initiatives

1. Unambiguous endorsement and engagement by national and institutional discipline leaders; Deans of Science, Biotechnology Programme co-ordinators and founders. This offers extensive organisational memory important for making effective judgements.
2. Well developed collaboration and representation across the sector and with expert and stakeholder groups; A five-year history of collaboration with the majority of the team members. Support from Deans of our respective Faculties, as well as DVCs. Support from industry representatives from the peak industry body and from at least twenty direct company endorsements.
3. Clear vision and well developed strategies for generating a direction for future discipline leaders; Phase One of the AUTC study provided substantial high quality data upon which to base our judgements. Utilising this data in Phase Two we developed a number of initiatives which proved successful or at least has substantial potential for success. We have outlined the achievements of our AUTC project and illustrated a number of major and minor outcomes directly attributable to the project. In this Carrick Institute proposal, we are seeking to build upon this successful track record
4. Engagement of the principles of the Discipline-based Initiatives Scheme The principles have been closely studied in the preparation of this proposal, which is in line with our successful completion of Phases 1 and 2 of the AUTC biotechnology study. The Values of Carrick have also been closely considered and adhered to in this process, as outlined in the succeeding paragraphs. In other words, we are aiming to improve university teaching and learning, in this case in the area of biotechnology, and we are aiming to do so by building the 'community of practice' of those who run and teaching into biotechnology degree programs.
5. Clear plan for managing and distributing the funds; The budget allocation processes have been clearly enunciated. University of Queensland will be the administering University, as it took over as the coordinating university in Phase Two of the AUTC study.

The budget development has been agreed by all team members. The funds allocation process will be revisited at each team meeting, at bimonthly intervals. The accounts established for AUTC will be reused and updated for consistency and transparency. Financial reports will be made to Carrick on a quarterly basis.

6. Appropriate budget justification. Budget allocations have been extensively explained and justified in the accompanying budget section.

3 *Goals (deliverables)*

Specific deliverables from the initiatives that will be scoped under this proposal include:

Initiative	Deliverable
Cross-disciplinarity best practice identification, as well as identifying diversity in programs and practices	Documentation of best practice models
Uni-BEN	Updated rejuvenated network of Biotechnology educators in all States and an increase in links to industry and student representative groups.
National Industry placement scheme	Report on feasibility of a scheme for establishing 500 industry placements per year.
Web site development	Web site access by and relevance to all stakeholders.
Integrating problem-based learning into existing Biotechnology programs at the member universities	Feasibility of enhancing curricula in participating universities with integration of PBL in core courses over an estimated two-year effort.
Comparing beyond Biotechnology Programs	Documentation of lessons from programs in Engineering and Health about PBL and the management of cross-disciplinarity. The results disseminated through the web site.
Integrating industry input into skills requirements and expectations	Results of industry surveys and exploration of full industry funding of ongoing surveying and trend analyses of skills requirements based upon technology trajectories tracked by such surveying
Graduate Attribute Identification & Curriculum Mapping for Biotechnology Degree Programs	A clearly articulated strategy and buy-in commitments for a three-step program in rolling out curriculum mapping in biotechnology programs nationally.
A 'how to' booklet on establishing a successful biotechnology program	A report on successful management practices in biotech programs gleaned from our national survey.
Collaborating and comparing with programs internationally	Detailed case studies of best practice international programs as well as exploration of enhanced collaboration with these programs.
A graduate engagement strategy through alumni	The feasibility of this sort of alumni program will be explored for team member universities first and then to others in the Uni-BEN fold.
Association with ABEN, the K-12 biotechnology education organisation	MOU with ABEN, followed by attendance at each other's conferences, resource sharing, and web links.
School visits program and resource materials	Initial overview of proven strategies for improving understanding of Biotechnology amongst students in both primary and high school as well as parents and public.
Shadow an industry person for a day	Report on the feasibility of -- and provide a rough set of instructions for -- exposure to industry practice by lecturing staff, leading to more relevant curriculum design.

4 Building on past Success

Has there been any prior discipline-based initiatives (either in your discipline or another) upon which this investigation and scoping is based? If so identify them and describe how they are being used and built upon.

Outcomes of phase one and phase two of the AUTC project: A platform to build upon.

The main goal of the first two phases of the AUTC National Biotechnology Skills Study was to help align the teaching program formats in Universities with current and future industry needs given the cross-disciplinary nature of biotechnology. The outcomes of Phase 1 of the study were presented in detail in our Phase 1 Report entitled: *Review of Biotechnology in Australia*.

A process of building relationships between university biotechnology educators and industry employers, who hire their graduates, was begun. These links were enabled, in part, by dissemination in 2003 and 2004 of the Phase 1 final report of this project, which has been distributed to over 350 individuals in both academic and industry sectors. Research and distribution were funded by the Australian Federal Government's Department of Education, Science and Training to determine "if universities are offering programs that will meet the needs of Australia's growing biotechnology industry." Phase 1 research found that Australian universities are producing a sufficient number of graduates with much of the knowledge and many of the qualities desired by this rapidly evolving industry.

Building the University Biotechnology Community

- Phase 1 findings revealed what was studied in undergraduate biotechnology degree programs nationwide as well as industry requirements – numbers and abilities of graduates needed.
- Phase 2 focused on disseminating these findings while building relationships among university biotechnology educators and between university educators and industry.
- The Phase 2 effort initiated the sharing of effective strategies for teaching and for industry placements through establishment of a national *University Biotechnology Educators Network* (Uni-BEN). Uni-BEN held its first meeting in November 2004 in Brisbane. Delegates rated the gathering as a 'success,' requesting ongoing meetings on a biennial basis. Uni-BEN *de facto* encompasses over two-hundred university lecturers spread across the twenty-six Australian universities that offer biotechnology degree programs.
- A database of biotechnology lecturers was extended to include 238 academics plus 100 other university administrators (e.g., deans) and industry representatives; all received a hard or soft copy of this study's Phase 1 report.
- Uni-BEN will soon have a listserv developed in response to input from members.
- Links were made between our team organising the Uni-BEN meeting and a fledgling *Australian Biotechnology Educators Network* (ABEN). ABEN is aimed at individuals who bring biotechnology education to K-12 and public venues. Ongoing consultation and collaboration has resulted.
- Australian Biotech Education Website -- A website was established at -- <http://calfp6.fmc.flinders.edu.au/Uni-BEN/>. This site was used for providing information about the inaugural Uni-BEN meeting. Reference to the Uni-BEN meeting was also provided on a website for registration for the national AusBiotech conference. We negotiated for a more permanent link with the AusBiotech website as well as web links with Biotechnology Australia and other organisations.

Industry Focus – Raising Industry Awareness

The quality of university biotechnology degree programs characterised in the Phase 1 effort was evaluated, in this Phase 2 effort, in terms of employer satisfaction with graduates. Focus groups, a university-industry forum, and interviews were conducted in Adelaide, Melbourne, Brisbane, and Sydney to investigate abilities actually observed in graduates of biotechnology programs. Discussions also addressed ways of aligning graduate abilities and attributes with industry expectations on an ongoing basis.

- The Phase 1 report was distributed and presented in companies and peak organisations in industry as well as in government, stimulating interest in ongoing information and dialogue.
- Phase 2 focus groups, a university-industry forum, and interviews were conducted in Adelaide, Melbourne, Brisbane, and Sydney to investigate abilities actually seen in graduates of biotechnology programs and how those attributes and industry expectations can be aligned.
- Biotechnology graduates are seen to be confident in using computers and laboratory equipment but need more scientific and statistical knowledge, and they need to write better.
- Graduates receive some mentoring in industry and a range of types of training; despite their ambition, graduates have limited advancement opportunities in small companies.

Employers voiced particular concern about "business" aspects of programs gaining too much emphasis and displacing content in areas of basic science, such as chemistry. They see knowledge of fundamental science as essential in the small firms that tend to predominate in Australia's biotechnology industry.

One of the major findings from Phase 2 was that People in industry want to build on existing relationships with universities in order to understand degree programs more thoroughly; they also want academics to understand what it is like to work in industry

The results suggested some areas of tension between industry desires and the knowledge and range of abilities that graduates are demonstrating. Positively, though, employers voiced a desire for a greater understanding of biotechnology degree programs, and they would like biotechnology academics to have a greater experience of what it is like to work in industry.

Achievements from the AUTC Phase One and Two projects:

Initiatives resulting from the extensive work undertaken in the two phases include

- Monash Biotechnology program established.
- Best practices disseminated
- Uni-BEN established
- Stronger linkages with industry
- Better industry involvement in Biotechnology programs
- Stakeholder buy in from within the university system
- Support from Deans of Science
- Publicity on Science Skills include *BRW* and *Australasian Science* articles
- Invited conference papers
- Increased cooperation between partner universities
- Involvement of science communication specialists to assist in the communication and dissemination process.
- Policy influence from the reports and from subsequent papers and discussions.

Examples of specific outcomes at universities include:

- The AUTC report was used to support the case for refurbishing the chemistry building and chemistry teaching labs at UQ.
- The report has spurred our undergraduate biotech program to achieve increased involvement of industry in delivering content into our undergraduate program and hosting industry site visits. We have guest lecturers now from Progen PanBio, Agen, Cook, AIC, BCI. We have site visits to seven local companies. The program now has more industry funded honours projects through the CEED and Uniche programs (Orica funded) and DPI. The effect has been a heightening of motivation to capture the desire expressed by respondents for more industry involvement.

Key findings published

Findings of our Phase 1 and Phase 2 efforts have been publicised through meetings and correspondence. We also received coverage in biotechnology newsletters and in the newspaper following release of the Phase 1 report in 2003.

Phase 1 and 2 results, as well as the reports themselves were disseminated to everyone in the biotech educators directory, some 350 individuals across the Australian university community as well as over sixty companies.

Phase 1 results and advertisement for the Uni-BEN meeting were also presented at the UniServe Science conference (at the University of Sydney) and at the ABEN meeting (in Coolangatta) in early October 2004, and at a global education conference hosted by Singapore Polytechnic in May 2004, which helped to place this investigation of Australian biotechnology education in an international perspective.

The initiatives established under the AUTC project have broadened with the involvement of Professor Mick McManus, the Executive Dean of the Faculty of Biological and Chemical Sciences at UQ, Damian Hine, Ross Barnard, Louise Mattick, who have an article soon to be published in *Australasian Science* (See Appendix Two) and have had a major article about their work, on developing science skills in Australia, published by the *Business Review Weekly* (See Appendix Three) so far this year.

5 **Impact**

What is the value of the proposal to the development of the Discipline and student learning outcomes and experience?

Extensive value can be generated from the work outlined in this proposal for the entire Biotechnology sector. Value will be achieved for each of the stakeholder groups through the initiatives scoped in this document. The following provides a list of the stakeholder groups identified in Section 10. These groups are then matched with the initiatives outlined in this proposal to identify which stakeholder groups will benefit most from each initiative either undertaken or whose feasibility is assessed.

1. **Students**
2. **Staff and Universities**
3. **Industry**
4. **The Public**
5. **Other educators and institutions**

Initiative	Stakeholder group gaining value
Cross-disciplinary best practice identification, as well as identifying diversity in programs and practices	1, 2, 5.
Uni-BEN and ABEN liaison	1, 2, 5.
National Industry placement scheme	1, 3.
Web site development	1, 2, 3, 4, 5.
Integrating problem-based learning into existing Biotechnology programs at the member universities	1, 2.
Comparing beyond Biotechnology Programs	1, 2, 3, 5.
Integrating industry input into skills requirements and expectations	1, 2, 3.
Graduate Attribute Identification & Curriculum Mapping for Biotechnology Degree Programs	1, 2, 3.
A 'how to' booklet on establishing a successful biotechnology program	1, 2, 3.
Collaborating and comparing with programs internationally	1, 2, 3, 5.
A graduate engagement strategy through alumni	1, 2, 3.
Association with ABEN	1, 2, 3, 5.
School visits program and resource materials	2, 4, 5.
Shadow an industry person for a day	1, 2, 3.

6 **Value to the Sector**

How does this proposal address any national priorities or workforce and/or skill development agendas?

Finding means of meeting the rapidly changing needs of an emerging industry such as Biotechnology is critical. Not only has the number of graduates been identified as a critical issue, even by the Federal Government, but the quality of graduates is of utmost importance to building a strong industry platform. The outcomes of the AUTC study, and the two papers referred to in the Appendices attached to this proposal, provide further support and evidence that members of this team have been closely involved in driving this agenda rather than simply observing it.

The proposed study addresses a range of areas that are critical to serving these needs through identification of effective teaching, effective curriculum update and program governance methods, and effective liaison with key stakeholder groups, industry, education, and the public.

7 Engage with the Values and Principles of the Carrick Institute

How will the proposal address the values, outcomes and principles of the Discipline-based Initiatives?

Our project adheres to the clearly enunciated Carrick values of inclusiveness, diversity, long-term change collaboration and excellence in two major ways.

1. The team selected to take this project forward exemplifies many of these values. We have representatives from four universities, from four different states in our team. Our team members come from diverse schools and departments including a business school, medical school, school of Molecular and Microbial Sciences, a Biomedical school, and a Department of Science and a Faculty of Science and Engineering. The team includes an extensive array of skills and backgrounds, providing an expansive perspective on a very diverse industry. Most of the members of this team have collaborated successfully in the AUTC Biotech project during the last five years, achieving solid outcomes, which have been verified by the independent assessor for the AUTC. Our newer member from Monash University has collaborated closely with the existing members of the team in developing a new Biotechnology program at Monash University based upon the findings, knowledge and principles emanating from the AUTC project.
2. The project we propose as an extension of what has been achieved already under the AUTC auspices seeks to ensure data is collected from across the nation, that as with our Uni-BEN (University Biotechnology Education Network) initiative, universities and industry leaders from all states and territories are represented and included in discussions and input, as well as in the network building we will continue to achieve. While these networking efforts have slowed in the past year, correspondence has been maintained, making the scaling up of the network again a relatively rapid task. The Uni-BEN initiative has already gained the full support and endorsement of the peak national industry body for Biotechnology, AusBiotech.

8 Interdisciplinary Possibilities

What opportunities will there be for cross disciplinary collaboration?

In our original AUTC study, we learned by sharing ideas with the members of other disciplinary study teams. For example, we saw the Nursing study as a model and compared notes with colleagues conducting the studies in Physics and Psychology. It is intended that such cross-fertilisation of ideas will continue under these current Carrick initiatives.

The proposed study is naturally interdisciplinary, as well, in that Biotechnology is a cross-disciplinary area with many sub-fields that has been built on such a collaborative approach. For example, some of those who teach into biotechnology degree programs are based in a school or department of biotechnology, but many – if not most – are housed academic units for their own discipline, e.g., chemistry or microbiology. In fact, one of our aims in completing this study, and any follow up work, is to identify best practices in creating and managing these sorts of interdisciplinary programs.

9 Cross Disciplinary Learning

What potential learning or application is there for other disciplines?

Biotechnology is a leader in achieving results through cross-disciplinary collaboration. Without it, there can be little advancement of science or learning. This is evidenced by the diverse backgrounds and

With increasing attention to the interdisciplinarity needed in science, our findings and initiatives for biotechnology should be useful for colleagues working in similarly interdisciplinary areas of science, such as nanotechnology or forensic science, and the increasing number of

interdisciplinary areas outside science, such as business information systems and media studies.

Our findings about effective teaching practices in the applied sciences would carry important messages for colleagues in the pure sciences, particularly in light of the increasing proportion of their teaching in service subjects. In other words, if we can identify effective teaching of chemistry for biotechnology students, that should have implications for how to teach chemistry effectively to engineering students and biology majors.

10 Stakeholder Engagement

Who are the stakeholders in your discipline and how will they be involved?

The scoping activities proposed can be considered under the major stakeholder groups involved in developing learning opportunities that are industry relevant. Under each are listed the main scoping issues we have identified. We have matched these issues with initiatives whose feasibility we will assess, initiatives identified to extend the achievements of the AUTC study.

The major stakeholders, issues and scoping initiatives under consideration.

Students

Industry relevant skills sets and experience – National Industry Placements Scheme and graduate attribute identification and curriculum mapping.

Enhancing the holistic learning experience for students to equip them for their industry roles - Integrating problem-based learning, as one strategy, into existing Biotechnology programs at the member universities.

Staff and universities

Cross-disciplinarity – Best practice identification, as well as identifying diversity in programs and practices in both scientific and business aspects of programs.

Information and resource sharing – Uni-BEN and web site development

Best practice examples from outside Biotechnology

Aligning teaching and research – collaboration with the Deans of Science, involvement in the development of the Science Teaching Centre at UQ.

Best practice programs - Developing a “How To” Booklet on designing a Biotechnology program.

Industry

Engagement with university programs – National Industry placement scheme and Web site development

Skills meeting needs

Predictability of rapid technology development

Graduate input into the curriculum – a graduate engagement strategy through alumni

Gauging current and future industry skills requirements – administering a new of industry survey to update data and build a trend analysis of skills needs leading to a predictive model

The public

Engaging with the public and wider society as users of biotechnology products - Web site development

Other educators and institutions

Association with ABEN

School visits program and resource materials

Through this proposal, we are seeking to synchronise with the efforts of the Deans of Science. We are corresponding currently through our own Dean of Science in the member universities. The buy in by national and institutional disciplinary leaders, particularly the Deans of Science, is critical. Our own Deans endorse the study, and we will ensure that our project aligns with the larger project covering all of Science (which is being directed by Canberra – Uni of Canberra and ANU). Issues such as cross disciplinary focus, at least as one element in the proposal, are of interest to the science deans.

BUDGET

The proposed budget reflects the work involved in updating data gathered in our AUTC Biotech study, determining the feasibility of each of a range of possible future developments in the community of Australian biotechnology degree programs (such as a number of the initiatives listed below), as well as making possible meetings every three months during the study period among the principal team members.

1. Identification of best practices in managing a program that requires teaching from across a range of disciplines – from basic science to applied science to business skills and insights. , – **Flinders and Monash**
2. Uni-BEN (University Biotechnology Educators Network) for sharing best practices in teaching, curriculum development, and industry links; updating our members' list and exploring possible ways of sharing best practices effectively – **Flinders**
3. National Industry placement scheme – **Monash and UQ**
4. Web site development to support national initiatives, such as Uni-BEN and placement scheme - **Flinders**
5. Integrating problem-based learning into existing Biotechnology programs at the member universities – **UNSW**
6. Comparing beyond Biotechnology Programs – **All members**
7. Integrating industry input into skills requirements and expectations – **UQ**
8. Graduate Attribute Identification & Curriculum Mapping for Biotechnology Degree Programs – **Flinders** and **UNSW**
9. A 'how to' booklet on establishing a successful biotechnology program – **Monash/UQ**
10. Collaborating and comparing with programs internationally – **UQ and UNSW**
11. A graduate engagement strategy through alumni – **All members**
12. Association with ABEN – **Flinders and UNSW**
13. School visits program and resource materials – **All members**
14. Shadow an industry person for a day – **Flinders and Monash**

TYPE	DETAILS	FUNDING SOUGHT
Project officer -- Research assistance	600 hours Research assistance @ \$37/hour (including on-costs) – project officer: conducting follow up on AUTC biotech study's surveys of degree programs and industry needs; implementing strategies to address the feasibility of initiatives listed above; point of contact for biotech academics and industry staff; 2 days/wk.	29600
Administrative assistance	400 hours Admin assistance @ \$35/hour (including on costs) – administrative coordination among study team members, updating information on biotech programs and biotech industry contacts, and detail work on publication and dissemination; 1 day/wk.	14000
Technical assistance	250 Hours IT Technical Assistance @ \$49/hour (including on costs) -- development and administration of online surveys (building on those employed in AUTC Biotech surveys), format and illustration for reports, and development of website	12250
Staff time	Relief from marking and other ancillary duties for project principals	15000
Travel for meetings	Team members to meet every three months at a selection of hub cities.	20000
Travel to industry forums	Industry contact and liaison by project staff, travel to industry forums for interviews, surveys, publicity, and building relationships.	3500
Conference presentations	Conference attendance and presentation (3x Australian-based conferences)	2000
Telephone, consumables, equipment for project officer, and publication costs	Teleconferences, publication and distribution of report and any resources to the Australian biotech community in hard copy and electronically	3500
	TOTAL (exc GST)	99850
In kind	<i>TIME OF PROJECT PRINCIPALS IN PLANNING RESEARCH, FORGING CONTACTS, AND ANALYSING AND DESCRIBING RESULTS – @ APPROX. 2 DAYS/MONTH X 12 MONTHS</i>	80000

Budget Justification (Explain the contribution and importance of each budgetary item to the success of the investigation).

Staffing:

The proposed budget for this project centres on use of a project officer along with administrative assistance mainly to update and extend information gathered in the AUTC Biotech study. A small measure of additional administrative support and related materials costs are also budgeted as well as the cost of a computer for the project officer.

Web programming assistance is needed, as in our AUTC Biotech study. The online survey that we produced in that effort proved effective, but it will need to be modified to permit respondents to update quickly the data they had entered in our previous study (rather than taking the hours required to enter that data initially).

A modest amount of funding per team principal has been set aside for relief from marking and other ancillary duties to permit commitment of time to this project.

The in-kind commitment of time by the project principals is estimated at two days per month or about \$80,000 for the year.

Team meetings:

The academic team members will be meeting at intervals of three months, first to formulate the extended surveys and feasibility studies (noted at the top of this page) and then to audit and discuss progress, and finally to analyse collated results. A fourth team meeting is included to formulate a proposal for follow-on work deemed feasible and desirable by the research completed.

Other travel:

Travel to industry forums to interview and survey industry counterparts is needed as is the opportunity to present findings and hold workshops at key academic conferences where members of the biotechnology community meet.

Endorsement of VC/ DVC of Lead Institution **Professor Michael Keniger** See attached endorsement with signature

Name of Lead Institution **University of Queensland**

List other Institutions

University of New South Wales

Flinders University

Monash University

.....

Endorsement of Stakeholders

☐ See attached endorsement/s from stakeholders

List

Stakeholders.....

.....

.....

Submit this completed form by mail and email to:

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Program Administrator

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Office of the Deputy Vice-Chancellor (Academic)

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Attachment One

4 August 2006

Institutional Endorsement

I am pleased to endorse the expression of interest submitted by Associate Professor Ross Barnard and Dr Damian Hine, *Extending teaching and learning initiatives in the cross-disciplinary field of biotechnology*. This investigation aims to build upon the findings of the AUTC Biotech study and to further encourage national collaboration by educators in this field.

The study proposed by Professor Barnard and Dr Hine would enable the University sector to make significant improvements across a range of issues including; dissemination of best practice in learning and teaching and program management, improving disciplinary coordination and networks, and developing an industry placement scheme.

Through the dissemination strategies proposed a significant contribution would be made to the higher education sector in developing and distributing resources and expertise in the field of biotechnology.

The importance of this proposal is evident the collaboration by four universities with significant interests in the field of biotechnology. Collaboration across the sector on Carrick projects is strongly supported by the University of Queensland and I commend this proposal to you for consideration.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Michael Keniger', with a large, stylized loop at the end.

Professor Michael Keniger
Deputy Vice-Chancellor (Academic)